# EXHIBIT 6

**Exhibit F4-008P**
**Invalidity of U.S. Patent No. 8,090,008 based on Müller**

"A Comparison of Peak Power Reduction Schemes for OFDM" by Stefan H. Müller and Johannes B. Huber ("Müller"), was published in GLOBECOM 97, IEEE Global Telecommunications Conference, Conference Record (1997). Müller is therefore prior art to U.S. Patent No. 8,090,008 ("the '008 Patent") under at least 35 U.S.C. §§ 102(a), (b), and/or (e).

This invalidity claim chart is based in whole or in part on Nokia's present understanding of the asserted claims, its current construction of the claims, and/or TQ Delta's apparent construction of the claims in its current infringement contentions. Nokia is not adopting TQ Delta's apparent claim construction, nor admitting to the accuracy of any particular claim construction. To the extent that TQ Delta's apparent claim construction or applications thereof are reflected in this invalidity claim chart, nothing herein should be construed as an admission that Nokia agrees with TQ Delta's apparent claim construction or TQ Delta's application of that claim construction in TQ Delta's current infringement contentions.

The use of this reference or combinations of references as invalidating prior art under 35 U.S.C. §§ 102 and/or 103 may be based on TQ Delta's allegations of infringement. Nokia does not necessarily agree with the interpretations set forth in TQ Delta's infringement contentions and thus this invalidity claim chart is not an admission that the accused products meet any particular claim element or infringe the asserted claim. In addition, nothing in this invalidity claim chart should be interpreted as a position about whether any portion of the asserted claim is limiting or not. Further, by submitting this invalidity claim chart, Nokia does not waive and hereby expressly reserves its right to raise other invalidity defenses, including but not limited to defenses under 35 U.S.C. §§ 101 and/or 112.

Nokia reserves the right to amend or supplement this claim chart at a later date.

| Claim 14 | Müller Disclosure |
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| [14-pre] A multicarrier system including a first transceiver that uses a plurality of carrier signals for modulating a bit stream, wherein each carrier signal has a phase characteristic associated with the bit stream, the transceiver capable of: | To the extent that the preamble is deemed limiting, under at least TQ Delta's apparent theory of infringement, Müller discloses and/or renders obvious "a multicarrier system including a first transceiver that uses a plurality of carrier signals for modulating a bit stream, wherein each carrier signal has a phase characteristic associated with the bit stream:" |

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| | To the extent TQ Delta alleges that this limitation is not fully disclosed by Müller, this element would have been obvious to one of ordinary skill in the art based on the state of the art in existence at the time, the explicit and implicit teachings of this reference and the art, the differences between the art and the claimed limitation and the general knowledge of a person of ordinary skill in the art.<br><br>It was well known in the art to compute a phase shift for each carrier signal based on the value associated with that carrier signal. For example, each of the references in charts F4-008A – F4-008G; F4-008I – F4-008L; F4-008N – F4-008P and F4 Secondary - 008 teach this limitation. It would have been obvious to one of ordinary skill in the art to combine the teachings of Müller with any of these references, as they all teach methods or devices that compute a phase shift for each carrier signal based on the value associated with the carrier signal. For additional motivation to combine, see limitation 14[A]. |
| [14C] combining the phase shift computed for each respective carrier signal with the phase characteristic of that carrier signal to substantially scramble the phase characteristics of the plurality of carrier signals, wherein multiple carrier signals corresponding to the scrambled carrier signals are used by the first transceiver to modulate the same bit value. | Under at least TQ Delta's apparent theory of infringement, Müller discloses and/or renders obvious "combining the phase shift computed for each respective carrier signal with the phase characteristic of that carrier signal to substantially scramble the phase characteristics of the plurality of carrier signals, wherein multiple carrier signals corresponding to the scrambled carrier signals are used by the first transceiver to modulate the same bit value": |

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| | **Abstract** — Two powerful and distortionless peak power reduction schemes for Orthogonal Frequency Division Multiplexing (OFDM) are compared. One investigated technique is selected mapping (SLM) where the actual transmit signal is selected from a set of signals and the second scheme utilizes phase rotated partial transmit sequences (PTS) to construct the transmit signal. Both approaches are very flexible as they do not impose any restriction on the modulation applied in the subcarriers or on their number. They both introduce some additional system complexity but nearly vanishing redundancy to achieve markedly improved statistics of the multicarrier transmit signal. The schemes are compared by simulation results with respect to the required system complexity and transmit signal redundancy.<br><br>*See, e.g.*, Müller at Abstract. |

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| | Besides a lot of advantages, some drawbacks become apparent, when using OFDM in transmission systems. A major obstacle is that the multiplex signal exhibits a very high peak–to–average power ratio (PAR). Therefore, nonlinearities may get overloaded by high signal peaks, causing intermodulation among subcarriers and — more critical — undesired out–of–band radiation. If RF power amplifiers are operated without large power back–offs, it is impossible to keep the out–of–band power below specified limits. This leads to very inefficient amplification and expensive transmitters so that it is highly desirable to reduce the PAR. A variety of methods for that purpose is proposed in literature (e.g. [4, 10, 3]).<br>Here, we concentrate on two recently proposed flexible and distortionless methods for the reduction of the PAR by way of introducing little redundancy. The SLM method [1, 2] (similar methods are described in [9, 5]) is compared to the PTS approach [8, 7]. In SLM the transmitter selects one favorable transmit signal from a set of sufficiently different signals which all represent the same information, while in PTS the transmitter constructs its transmit signal with low PAR by coordinated addition of appropriately phase rotated signal parts.<br>Section 2 recapitulates OFDM signaling. In Section 3 we report statistical characteristics of the OFDM transmit signal. The two investigated PAR reduction schemes are looked at again in Section 4. Simulation results to compare their performance are presented in Section 5. There, the PAR reduction capability of both schemes is set against the theoretical limit of achievable minimum PAR versus redundancy and we will find that they are considerably near this limit. |

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| | **2. OFDM TRANSMISSION**<br><br>The idea of OFDM is to use $D_u$ separate subcarriers, having a uniform frequency spacing. The frequency multiplexing is implemented by using the inverse discrete Fourier transform (IDFT) for $D$–ary ($D \geq D_u$) vectors in the modulator.<br>At first, binary data is mapped onto $D_u$ carriers. Thereby, subcarrier $\nu$ of OFDM symbol interval $\mu$ is modulated with the complex coefficient $A_{\mu,\nu}$. Here, we assume that in all $D_u$ active carriers the same complex–valued zero–mean signal set $\mathcal{A}$ with variance $\sigma^2_{\mathcal{A}}$ is used, but the results can easily be extended to mixed signal constellations. Inactive carriers are set to zero in order to shape the power density spectrum of the transmit signal appropriately.<br><br>*See, e.g.*, Müller at 1.<br><br>**4. REDUCING PEAK POWER IN OFDM**<br><br>*4.1. SELECTED MAPPING*<br><br>In this most general approach [1, 2] it is assumed that $U$ statistically independent alternative transmit sequences $\mathbf{a}_{\mu}^{(u)}$ represent the same information. Then, that sequence $\tilde{\mathbf{a}}_{\mu}$ = |

$\mathbf{a}_\mu^{(\tilde{u}_\mu)}$ with the lowest PAR, denoted as $\tilde{\chi}_\mu$, is selected for transmission. The probability that $\tilde{\chi}_\mu$ exceeds $\chi_0$ is approximated by [2, 5]

$$\Pr\{\tilde{\chi}_\mu > \chi_0\} = \left(1 - \left(1 - \mathrm{e}^{-\chi_0}\right)^D\right)^U. \qquad (5)$$

Because of the selected assignment of binary data to the transmit signal, this principle is called selected mapping in [2, 6].

A set of $U$ markedly different, distinct, pseudo-random but fixed vectors $\mathbf{P}^{(u)} = [P_0^{(u)}, \ldots, P_{D-1}^{(u)}]$, with $P_\nu^{(u)} = \mathrm{e}^{+\mathrm{j}\varphi_\nu^{(u)}}$, $\varphi_\nu^{(u)} \in [0, 2\pi)$, $0 \leq \nu < D$, $1 \leq u \leq U$ must be defined. The subcarrier vector $\mathbf{A}_\mu$ is multiplied subcarrier-wise with each one of the $U$ vectors $\mathbf{P}^{(u)}$, resulting in a set of $U$ different subcarrier vectors $\mathbf{A}_\mu^{(u)}$ with components

$$A_{\mu,\nu}^{(u)} = A_{\mu,\nu} \cdot P_\nu^{(u)}, \quad 0 \leq \nu < D, \quad 1 \leq u \leq U. \qquad (6)$$

Then, all $U$ alternative subcarrier vectors are transformed into time domain to get $\mathbf{a}_\mu^{(u)} = \mathrm{IDFT}\left\{\mathbf{A}_\mu^{(u)}\right\}$ and finally that transmit sequence $\tilde{\mathbf{a}}_\mu = \mathbf{a}_\mu^{(\tilde{u}_\mu)}$ with the lowest PAR $\tilde{\chi}_\mu$ is chosen. The SLM–OFDM transmitter is depicted in Fig. 1, where it is visualized that one of the alternative subcarrier vectors can be the unchanged original one.

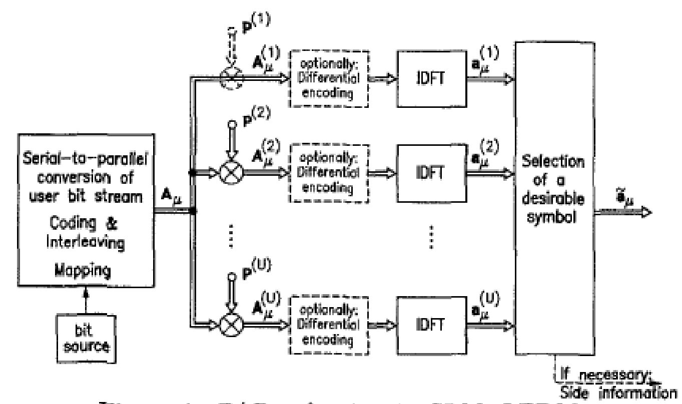


Figure 1: *PAR reduction in SLM–OFDM.*

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| | Optionally, differentially encoded modulation may be applied before the IDFT and right after generating the alternative OFDM symbols. At the receiver, differential demodulation has to be implemented right after the DFT.<br><br>*4.2. PARTIAL TRANSMIT SEQUENCES*<br>In this scheme [8, 7] the subcarrier vector $\mathbf{A}_\mu$ is partitioned into $V$ pairwise disjoint subblocks $\mathbf{A}_\mu^{(v)}$, $1 \leq v \leq V$. All subcarrier positions in $\mathbf{A}_\mu^{(v)}$, which are already represented in another subblock are set to zero, so that $\mathbf{A}_\mu = \sum_{v=1}^{V} \mathbf{A}_\mu^{(v)}$. We introduce complex–valued rotation factors $b_\mu^{(v)} = e^{+j\varphi_\mu^{(v)}}$, $\varphi_\mu^{(v)} \in [0, 2\pi)$, $1 \leq v \leq V$, $\forall\mu$, enabling a modified subcarrier vector<br>$$\check{\mathbf{A}}_\mu = \sum_{v=1}^{V} b_\mu^{(v)} \cdot \mathbf{A}_\mu^{(v)}, \qquad (7)$$ |

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| | which represents the same information as $\mathbf{A}_\mu$, if the set $\left\{b_\mu^{(v)}, 1 \leq v \leq V\right\}$ (as side information) is known for each $\mu$. Clearly, simply a joint rotation of all subcarriers in subblock $v$ by the same angle $\varphi_\mu^{(v)} = \arg\left(b_\mu^{(v)}\right)$ is performed. To calculate $\breve{\mathbf{a}}_\mu = \mathrm{IDFT}\left\{\breve{\mathbf{A}}_\mu\right\}$, the linearity of the IDFT is exploited. Accordingly, the subblocks are transformed by $V$ separate and parallel $D$–point IDFTs, yielding $$\breve{\mathbf{a}}_\mu = \sum_{v=1}^{V} b_\mu^{(v)} \cdot \mathrm{IDFT}\left\{\mathbf{A}_\mu^{(v)}\right\} = \sum_{v=1}^{V} b_\mu^{(v)} \cdot \mathbf{a}_\mu^{(v)}, \quad (8)$$ where the $V$ so–called partial transmit sequences $\mathbf{a}_\mu^{(v)} = \mathrm{IDFT}\left\{\mathbf{A}_\mu^{(v)}\right\}$ have been introduced. Based on them a peak value optimization is performed by suitably choosing the free parameters $b_\mu^{(v)}$ such that the PAR is minimized for $\tilde{b}_\mu^{(v)}$. The $b_\mu^{(v)}$ may be chosen with continuous–valued phase angle, but more appropriate in practical systems is a restriction on a finite set of $W$ (e.g. 4) allowed phase angles. The optimum transmit sequence then is $$\tilde{\mathbf{a}}_\mu = \sum_{v=1}^{V} \tilde{b}_\mu^{(v)} \cdot \mathbf{a}_\mu^{(v)}. \quad (9)$$ The PTS–OFDM transmitter is depicted in Fig. 2 with the hint, that one PTS can always be left unrotated. |

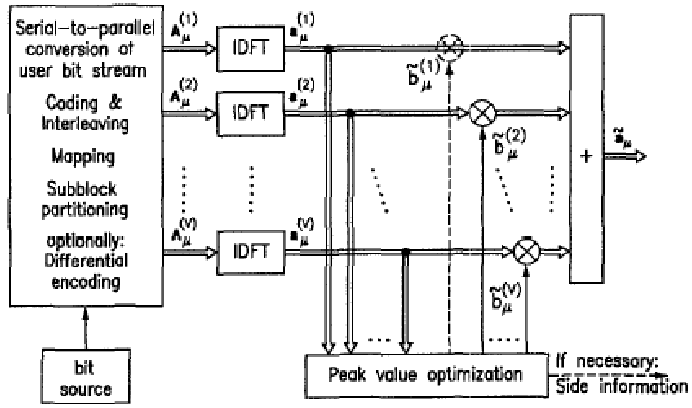


Figure 2: *PAR reduction in PTS–OFDM.*

We refer to [8, 6] for the discussion of an advantageous application of PTS employing differentially encoded modulation across subcarriers (i.e. in direction of frequency).

So far, no specific assignment of subcarriers to subblocks (subblock partitioning) has been given, but it has considerable influence on the PAR reduction capability of PTS. This topic is discussed in [7], where a pseudo–random (but still disjoint) subblock partitioning has been found to be the best choice for high PAR reduction.

It should be noted, that PTS can be interpreted as a structurally modified special case of SLM, if $W^{V-1} = U$ and the $\mathbf{P}^{(u)}$ are chosen in accordance with the PTS partitioning and all the allowed rotation angle combinations $\{b_\mu^{(v)}\}$. But with this construction rule, especially for a large number of vectors $\mathbf{P}^{(u)}$, their statistical independence is usually no longer satisfied, so that Eq. (5) does not hold any longer.

*See, e.g.*, Müller at 2-3.

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| | *4.3. REDUNDANCY (SIDE INFORMATION)*<br>Both schemes require, that the receiver has knowledge about the generation of the transmitted OFDM signal in symbol period $\mu$. Thus, in PTS the set with all rotation factors $\tilde{b}_{\mu}^{(v)}$ and in SLM the number $\tilde{u}_{\mu}$ of the selected $\mathbf{P}^{(\tilde{u}_{\mu})}$ has to be transmitted to the receiver unambiguously so that this one can derotate the subcarriers appropriately. The number of bits required for canonical representation of this side information is the redundancy $R_{\mathrm{ap}}$ introduced by the PAR reduction scheme with PTS and SLM. As this side information is of highest importance to recover the data, it should be carefully protected by channel coding, but the hereby introduced additional redundancy is not considered here.<br>In PTS the number of admitted combinations of rotation angles $\{b_{\mu}^{(v)}\}$ should not be excessively high, to keep the explicitely transmitted side information within a reasonable limit. If in PTS each $b_{\mu}^{(v)}$ is exclusively chosen from a set of $W$ admitted angles, then $R_{\mathrm{ap}} = (V-1)\log_2 W$ bits per OFDM symbol are needed for this purpose. In SLM $R_{\mathrm{ap}} = \log_2 U$ bits are required for side information.<br>Both schemes use the introduced redundancy to synthesize alternative signal representations, which all have to be checked for PAR. Clearly, their number is given by $2^{R_{\mathrm{ap}}}$. In SLM this value is $U$ while in PTS we obtain $W^{V-1}$ alternatives, a number which can get very high.<br>In PTS the choice $b_{\mu}^{(v)} \in \{\pm 1, \pm \mathrm{j}\}$ $(W=4)$ is very interesting for an efficient implementation, as actually no multiplication must be performed, when rotating and combining the PTSs $\mathbf{a}_{\mu}^{(v)}$ to the peak–optimized transmit sequence $\tilde{\mathbf{a}}_{\mu}$ in Eq. (9). For SLM, choosing $P_{\nu}^{(u)}$ from the latter set has the same advantage, when generating the alternative subcarrier vectors by applying Eq. (6).<br><br>*See, e.g.*, Müller at 3. |

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| | In PTS, an optimum pseudo–random [7] disjoint assignment of $\approx D/V$ subcarriers to each subblock is used. Here, the optimum $\tilde{b}_{\mu}^{(v)}$ are found by an exhaustive search over all combinations of rotation angles. For SLM, $U$ statistically independent rotation vectors $\mathbf{P}^{(u)}$ are used. The rotation vectors are actually obtained from random binary sequences mapped on 4PSK symbols. In Fig. 3 simulation results for $\Pr\{\chi_{\mu} > \chi_0\}$ achieved with $V$ PTS–subblocks, where each $b_{\mu}^{(v)}$ is chosen from a 4PSK–constellation ($W = 4$) are set against SLM–OFDM with $U$ alternative subcarrier vectors. Note that $V = U$ IDFTs are needed in either scheme but PTS will usually provide a greater multiplicity of signal representations to be checked for PAR. The simulated characteristic of original OFDM and the theoretical expression from Eq. (3) are plotted there as well and theory corresponds well with the simulation result. It follows from this diagram that PTS with $W = 4$ rotations and $V = 2$ IDFTs (and therefore 4 signal |

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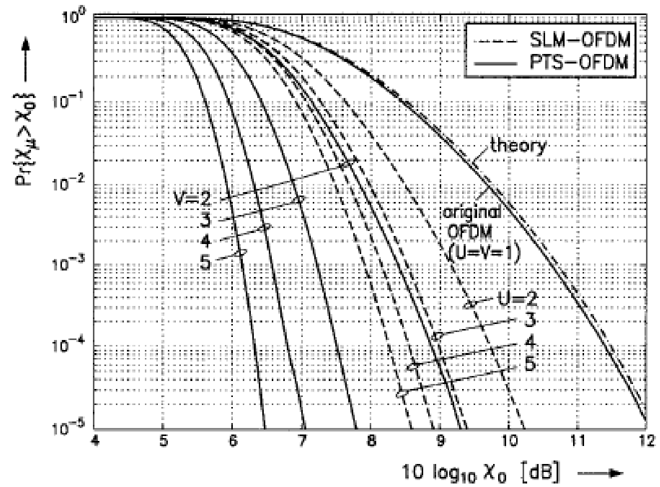
| | <br>Figure 3: *Probability that the PAR of a randomly generated 128–carrier OFDM transmit sequence exceeds* $\chi_0$ *for U IDFTs in SLM and V IDFTs in PTS with* $W = 4$.<br><br>representations) achieves a slightly better performance than SLM with $U = 3$ IDFTs (3 signal representations). The gap would get even larger if $W$ is further increased in PTS ($W$ signal representations, if $V = 2$). Generally, PTS outperforms SLM in PAR reduction, if the number of IDFTs is fixed, but clearly with more alternative signals to be processed.<br><br>*See, e.g.*, Müller at 3-4. |

Table 1 gives a compact overview of PAR reduction capability for SLM set against PTS with various allowed rotation angles, numbers of subblocks and, not considered so far, two different subblock partitionings. The entries provide information about the number of bits $R_{\text{ap}}$ for PAR reduction per symbol, and the number of possible signal representations ($2^{R_{\text{ap}}}$) enabled by this redundancy. They all have to be checked for PAR, if a selection by exhaustive search is performed. The PAR reduction gain $G_\chi \overset{\text{def}}{=} \chi_{\text{original}}/\chi_{\text{reduced}}$ at $\Pr\{\chi_\mu > \chi_0\} = 10^{-5}$ is given in the lower row. The $G_\chi^{\text{a}}$ achieved by a PTS subblock partitioning with exclusively adjacent subcarriers [6] is compared to the optimum $G_\chi^{\text{r}}$ realizable for pseudo–random subblock partitioning [7]. For PTS, each table entry has to be read like this:

| $2^{R_{\text{ap}}}$ | $R_{\text{ap}}$ [bit] |
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| $10\log_{10} G_\chi^{\text{a}}$ [dB] | $10\log_{10} G_\chi^{\text{r}}$ [dB] |

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| $V$,$U$ | 2 | | 3 | | 4 | | 5 | |
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| PTS | 2 | 1 | 4 | 2 | 8 | 3 | 16 | 4 |
| $W=2$ | 1.2 | 2.0 | 2.5 | 3.3 | 3.4 | 4.1 | 4.1 | 4.7 |
| PTS | 4 | 2 | 16 | 4 | 64 | 6 | 256 | 8 |
| $W=4$ | 2.1 | 3.0 | 3.6 | 4.4 | 4.5 | 5.2 | 5.1 | 5.8 |
| PTS | 8 | 3 | 64 | 6 | 512 | 9 | 4k | 12 |
| $W=8$ | 2.9 | 3.4 | 4.2 | 4.9 | 5.1 | 5.8 | ? | ? |
| PTS | 16 | 4 | 256 | 8 | 4k | 12 | 64k | 16 |
| $W=16$ | 3.0 | 3.6 | 4.2 | 5.1 | ? | ? | ? | ? |
| SLM | 2 | 1 | 3 | 1.6 | 4 | 2 | 5 | 2.3 |
| | 2.0 | | 2.8 | | 3.3 | | 3.6 | |

Table 1: *PAR reduction gain $G_\chi$ at $\Pr\{\chi_\mu > \chi_0\} = 10^{-5}$ for PTS–OFDM with $V$ subblocks and $W$ possible rotation angles compared to SLM–OFDM with $U$ alternative subcarrier vectors ($D = 128$).*

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| | Obviously, the pseudo–random assignment of subcarriers to subblocks is 0.5 to 0.9 dB better than the one with exclusively adjacent subcarriers per PTS subblock. The latter is an example for highly structured subblock partitioning, resulting in considerable performance degradation [7].<br>Note that for some combinations of $W$ and $V$ in PTS an exhaustive optimum search is prohibitive. Table 1 is for 128 carriers and clearly $G_\chi$ will be different for other carrier numbers but the tendencies recognizable therein are preserved, especially the fact that for PTS with fixed $R_{\mathrm{ap}}$ it is more advantageous to increase $V$ instead of $W$.<br>It follows from Table 1 that pseudo–random subblock partitioning in PTS ($W = 2$) with $V = 2$ and 3 performs equivalent to SLM with $U = 2$ and 4, respectively. This shows that for small numbers of $W^{V-1}$ and pseudo–randomized subblock partitioning in PTS, the $\mathbf{P}^{(u)}$ of the equivalent SLM scheme are still statistically independent. This implies that 4 alternative signal representations generated by PTS with 3 IDFTs plus some further vectorial additions achieve the same performance as SLM with 4 IDFTs.<br><br>*See, e.g.*, Müller at 4.<br><br>In PTS only 1.2% redundancy (cf. Fig. 3, $V = 4$) is needed to reduce the discrete–time PAR by 5.2 dB at $\Pr\{\chi_\mu > \chi_0\} = 10^{-5}$, achieving a stochastic PAR of quite low 7.1 dB in a 128 carrier system. If system complexity is ignored, SLM would even reduce the stochastic discrete–time PAR by 6 dB to 6.3 |

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| | dB with the same redundancy. SLM outperforms PTS in terms of PAR reduction vs. redundancy, but PTS is considerably better with respect to PAR reduction vs. additional system complexity (e.g. number of IDFTs) as it is capable to provide a greater manifold of alternative signal representations by using the same number of IDFTs together with some further vectorial additions. Obviously, complexity will be the main point of view, if practical OFDM systems are considered and so PTS (in an efficient implementational structure) will be a strong candidate.<br>PTS and SLM are near–optimum when PAR reduction capability vs. redundancy is considered. Thus, they seem to be the most powerful and flexible methods known to reduce OFDM peak power without nonlinear distortion.<br><br>*See, e.g.*, Müller at 5.<br><br>To the extent TQ Delta alleges that this limitation is not fully disclosed by Müller, this element would have been obvious to one of ordinary skill in the art based on the state of the art in existence at the time, the explicit and implicit teachings of this reference and the art, the differences between the art and the claimed limitation and the general knowledge of a person of ordinary skill in the art.<br><br>It was well known in the art to combine the phase shift computed for each respective carrier signal with the phase characteristic of that carrier signal to substantially scramble the phase characteristics of the plurality of carrier signals, wherein multiple carrier signals corresponding to the scrambled carrier signals are used by the first transceiver to modulate the same bit value. For example, each of the references in charts F4-008A – F4-008G; F4-008I – F4-008L; F4-008N – F4-008P and F4 Secondary - 008 teach this limitation. It would have been obvious to one of ordinary skill in the art to combine the teachings of Müller with any of these references, as they all teach methods or devices that send the same data bits on different carriers and this was a known technique in the art used to achieve a lower BER. For additional motivation to combine see limitation 14[A]. |